

RECLAMATION

Managing Water in the West

Appraisal Assessment of the Black Rock Alternative Delivery System for Sunnyside Division

A component of
Yakima River Basin Water Storage Feasibility Study, Washington

Technical Series No. TS-YSS-4



Black Rock Valley



U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region

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U.S. DEPARTMENT OF THE INTERIOR

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

MISSION OF THE BUREAU OF RECLAMATION

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

GLOSSARY AND ACRONYMS

Throughout this document, and unless otherwise noted:

Black Rock powerplant	A proposed powerplant near Roza Canal MP 22.6 at the proposed Black Rock outlet facility
Delivery systems	The proposed canal, pipeline, or tunnel systems that deliver water from the proposed Black Rock outlet facility to the existing downstream Roza and Sunnyside Divisions' canal systems for delivery to project lands
Downstream	In the direction of the water flow or current in Roza Canal
Facilities report	Refers to the <i>Appraisal Assessment of the Black Rock Alternative Facilities and Field Cost Estimates, Technical Series No. TS-YSS-4 December 2004</i> [6] report prepared by Reclamation's Denver Technical Service Center
Hydraulic grade line	The surface or profile of water flowing out of hydraulic gradient. The slope of the hydraulic grade line is under pressure; the hydraulic grade line is the actual level water would rise to in a small vertical tube connected to the pipe.
MP	Mile post – refers to locations on the Roza Canal with MP 0.0 being at Roza Diversion Dam
Outflow conveyance	The system and facilities that release water stored in a proposed Black Rock reservoir and convey it to a downstream Black Rock outlet facility
RM	River mile – refers to locations on either the Yakima River or the Columbia River
Station (Sta.)	Any one of a series of points indicating distance from a point of reference
Stationing	Increases in the direction of the water flow and decreases in the direction opposite of the water flow
Sunnyside Division	An irrigation entity comprised of Sunnyside Valley Irrigation District and eight other irrigation districts, companies, and cities

Sunnyside powerplant	A new powerplant proposed at Sunnyside Canal MP 3.83
Upstream	Toward the source of a stream or river; water in the delivery pipeline would flow upstream
USGS	U.S. Department of the Interior Geological Survey
Value Engineering	An organized team effort directed at analyzing the functions of processes, systems, equipment, facilities, services, and supplies for the purpose of achieving the essential functions at the lowest life-cycle cost consistent with required performance, reliability, quality, and safety.
WIS	Washington Infrastructure Services, Inc. – the contractor Brenton County, Washington, commissioned to study the technical feasibility and approximate cost of a Black Rock alternative.

PREFACE

Congress directed the Secretary of the Interior, acting through the Bureau of Reclamation (Reclamation), to conduct a feasibility study of options for additional water storage for the Yakima River basin. Section 214 of the Act of February 20, 2003, (Public Law 108-7) contains this authorization and includes the provision "... with emphasis on the feasibility of storage of Columbia River water in the potential Black Rock Reservoir and the benefit of additional storage to endangered and threatened fish, irrigated agriculture, and municipal water supply."

Reclamation initiated the *Yakima River Basin Water Storage Feasibility Study* (Storage Study) in May 2003. As guided by the authorization, the purpose of the Storage Study is to identify and examine the viability and acceptability of alternate projects by: (1) diversion of Columbia River water to the potential Black Rock reservoir for further water transfer to irrigation entities in the lower Yakima River basin as an exchange supply, thereby reducing irrigation demand on Yakima River water and improving Yakima Project stored water supplies, and (2) creation of additional storage within the Yakima River basin. In considering the benefits to be achieved, study objectives will be to modify Yakima Project flow management operations to most closely mimic the historic flow regime of a Yakima River system for fisheries, provide a more reliable supply for existing proratable water users, and provide additional supplies for future municipal demands.

State support for the Storage Study was provided in the 2003 Legislative session. The capital budget included a \$4 million appropriation for the Department of Ecology (Ecology) with the provision the funds "... are provided solely for expenditure under a contract between the department of ecology and the United States bureau of reclamation for the development of plans, engineering, and financing reports and other preconstruction activities associated with the development of water storage projects in the Yakima river basin, consistent with the Yakima river basin water enhancement project, P.L. 103-434. The initial water storage feasibility study shall be for the Black Rock reservoir project."

Reclamation's Upper Columbia Area Office in Yakima, Washington, is managing and directing the Storage Study. Pursuant to the legislative directives, Reclamation has placed initial emphasis on Black Rock alternative study activities. These study activities are collectively referred to as the Black Rock Alternative Assessment (Assessment).

The Assessment has three primary objectives. First, it provides the emphasis directed by Federal and State legislation. Second, it builds upon prior work and studies to provide more information on the configuration and field construction cost of the primary components of a Black Rock alternative. It examines legal and institutional

considerations of water supply and use, and identifies areas where further study is needed. Third, it is a step forward in identifying the viability of a Black Rock alternative.

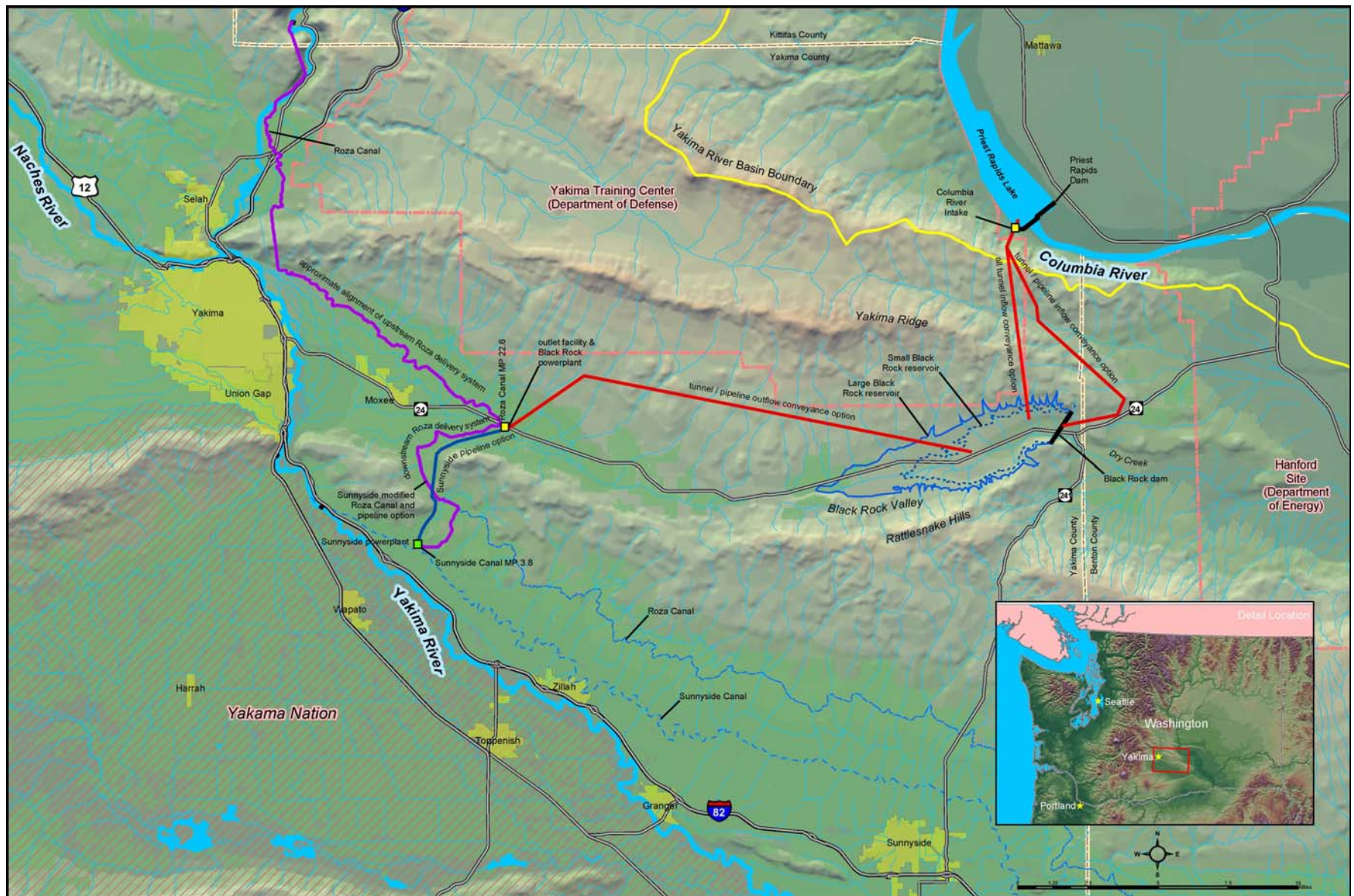
This technical document, prepared by Reclamation's Pacific Northwest Region, Boise, Idaho, is one of a series of documents prepared under the Storage Study. This particular document is a component of the Assessment reporting on preliminary appraisal-level engineering evaluation of designs and cost estimates of a potential Black Rock delivery system for the Sunnyside Division of the Yakima Project. Information and findings of this technical document are included in the Assessment Summary Report.

Further Consultations

The information available at this time is necessarily preliminary, has been developed only to an appraisal level of detail, and is therefore subject to change if this alternative is investigated further in the course of the Yakima River Basin Storage Feasibility Study (Storage Study). Finally, economic, financial, environmental, cultural, and social evaluations of the Black Rock alternative have not yet been conducted.

The policy of the Bureau of Reclamation (Reclamation) requires non-Federal parties to share the costs of financing feasibility studies and the eventual construction of Federal reclamation projects. In light of this policy, the preliminary cost estimates presented in the Assessment Summary Report, and current Federal budgetary constraints, Reclamation is not reaching a decision at this time as to whether the Black Rock alternative will be carried forward into the next phase of the Storage Study or dropped from further consideration. Rather, Reclamation will consult with the State of Washington (which is cost sharing in the Storage Study), the Yakama Nation, the potential water exchange participants, project proponents, and other interested parties before making a decision in this regard. It is anticipated that a decision will be reached by the fall of 2005.

If the Congress provides further funding for the Storage Study, all technically viable alternatives would be compared and an alternative(s) selected for further analyses in the feasibility phase. (Whether the Columbia River-Yakima River water exchange concept in the form of the Black Rock alternative is included will depend upon whether Reclamation, after these additional consultations, decides to carry that alternative forward into the plan formulation phase of the Storage Study.) The selected alternative(s) would then be subject to detailed evaluation in the feasibility phase in terms of engineering, economic, and environmental considerations, and cultural and social acceptability. This feasibility phase would be the last phase of the Storage Study. Preparation of the Feasibility Report/Environmental Impact Statement would be a part of this final phase.



Frontispiece. Overview of the Black Rock Alternative Configurations

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INTRODUCTION

The two identified Sunnyside Division delivery system plans (Downstream Plan 1 – delivery pipeline [Plan 1] and Downstream Plan 2 – modified Roza Canal and new pipeline [Plan 2]) start at Roza Canal MP 22.6 and end at Sunnyside Canal MP 3.83 as shown on Drawing No. 33-100T-3286 (Appendix A). The peak design flow with Sunnyside Division obtaining all of their water from the Columbia River is 1,262 cfs for both plans. While both plans include a Black Rock powerplant at Roza Canal MP 22.6, the Sunnyside Division receives powerplant discharge flows only under Plan 2. Table 1 summarizes the major features of these two plans.

Table 1. Summary of Black Rock Delivery System for Sunnyside Division

Item	Plan 1 Delivery Pipeline	Plan 2 Modified Roza Canal and New Pipeline
Extent of Columbia River water exchange	100 percent	
Beginning point of delivery	Roza Canal MP 22.6	
Peak capacity delivered	1,262 cfs	
Method of conveyance from Black Rock reservoir outflow conduit to Sunnyside Canal	new buried pipeline	enlarged Roza Canal facilities plus a new pipeline
Downstream point of delivery	Sunnyside Canal MP 3.83	
Delivery method to upstream water users	17 cfs via pressure pipeline	
Delivery method to downstream water users	1,245 cfs via Sunnyside Canal	
Estimated field construction cost at 2004 price levels (excluding Sunnyside powerplant and bypass structure costs)	\$210 million	\$68 million
Power generation	new Sunnyside powerplant at MP 3.83	

EXISTING WATER DELIVERY SYSTEM

The Sunnyside Division, extending about 60 miles, parallels and serves lands generally north and east of the Yakima River, as well as south of the river in the vicinity of the communities of Mabton, Grandview, and Prosser. Sunnyside Diversion Dam (RM 103.8) diverts Yakima River flows into the 1,320-cfs capacity Sunnyside Canal, the main conveyance facility which transports water to four irrigation districts, two ditch companies, and three cities totaling about 100,000 acres.¹ These entities collectively are referred to as the Sunnyside Division of the Yakima Project (see Figure 1).

The origin of Sunnyside Canal dates back to about 1878 when Konewock Ditch was constructed. Approximately 3,500 acres of the Konewock Ditch Company received their first Yakima River water in 1880. In 1890, the Northern Pacific, Yakima and Kittitas Irrigation Company made plans to enlarge and extend the ditch. The company entered into a contract with Konewock Ditch Company to supply water to its lands in exchange for purchase of the ditch and right-of-way. Purchase took place in 1893, canal enlargement followed, and the name of the ditch changed to Sunnyside Canal.

In 1900, the Washington Irrigation Company acquired the Sunnyside Canal and began selling lands for irrigated agriculture. The Reclamation Service (now Bureau of Reclamation) purchased the Sunnyside Canal in 1905 with the Washington Irrigation Company retaining 9,000 acres. The terms of the purchase required the Reclamation Service to provide water to the 9,000 acres and to honor previously executed water right contracts. The canal capacity at that time was 650 cfs serving about 40,000 acres.

The existing Sunnyside Division is the result of work performed by the Reclamation Service, and subsequently the Bureau of Reclamation (Reclamation) between 1906 and 1923. Reclamation initially operated and maintained the Sunnyside Division's diversion and conveyance facilities. Reclamation entered into contracts in 1945 with each entity establishing a Board of Control with responsibility for operation and maintenance of Sunnyside Canal and some ancillary facilities. The Board of Control is comprised of 12 directors representing entities of the Sunnyside Division. The Board of Control took over operation and maintenance of Sunnyside Diversion Dam in 1959. The Sunnyside Valley Irrigation District, largest of the entities, operates and maintains the Division's joint-use facilities on behalf of the Board of Control.

¹ These are the Sunnyside Valley Irrigation District, Grandview Irrigation District, Benton Irrigation District, Zillah Irrigation District, Konewock Ditch Company, Piety Flat Ditch Company, city of Grandview, city of Sunnyside, and the city of Prosser.

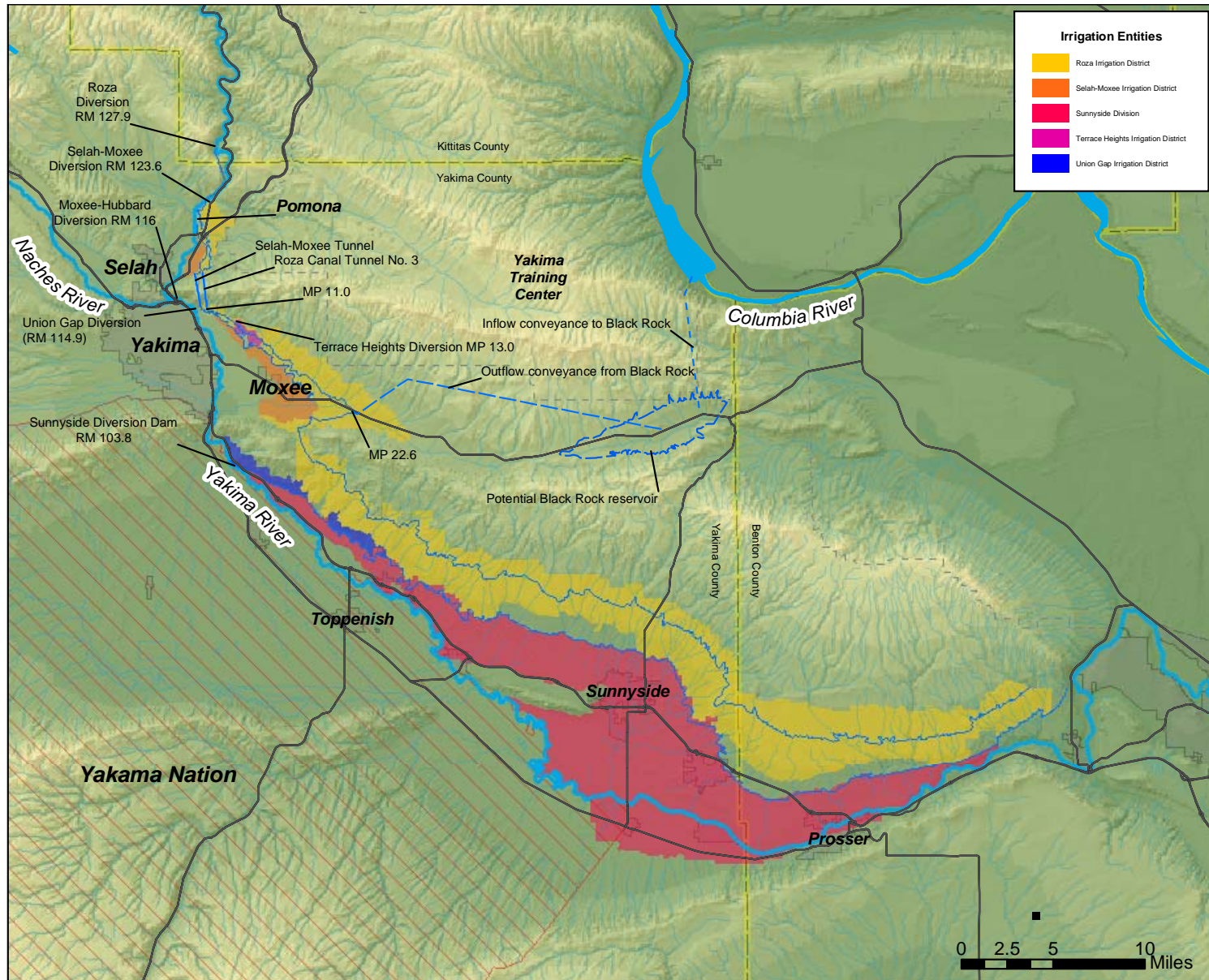


Figure 1. Overview of Sunnyside Division

Yakima River water rights of the Sunnyside Division for the April – October period originally totaled 458,520 acre-feet. However, the 2003 mediated settlement agreement and Conditional Final Order of the Adjudication Court reduced these water rights to 435,422 acre-feet. In addition, the Sunnyside Division can divert up to 12,000 acre-feet of “flood flows” in March when available. The 2003 mediated settlement agreement also provides for a reduction of water rights down to 415,972 acre-feet, and an instantaneous flow (the flow at a particular instant in time) of 1,262 cfs, by the year 2017. A further reduction down to 399,472 acre-feet, and an instantaneous flow of 1,216 cfs, is to occur at some future date. For purposes of preparing conceptual delivery plans for a potential Columbia River water exchange with the Sunnyside Division, the peak delivery requirement is 1,262 cfs.

PLAN 1 – DELIVERY PIPELINE

The 33,600-foot-long steel pipeline originates at a bifurcation structure on the Black Rock reservoir outflow conveyance system directly upstream from a new Black Rock powerplant. Drawing No. 33-100T-3287 (Appendix A) shows a plan view of the pipeline alignment. The alignment runs generally parallel to Roza Canal across orchards to the top of Konowock Pass, and then runs generally parallel to Konowock Pass Road downhill and across open land and orchards to Sunnyside Canal. Drawings Nos. 33-100T-3288, 33-100T-3289, and 33-100T-3290 (Appendix A) show the alignment and pipeline profile. Most of the 93 acres required for a 120-foot-wide construction right-of-way are through orchard land where Reclamation currently has no right-of-way.

Drawing No. 33-100T-3291 (Appendix A) shows a typical pipe trench section having a minimum 5-foot cover. A 6-inch-thick soil-cement slurry provides a gap filler in the haunch area of the pipe, to a height of about 0.25 times the pipe diameter. Compacted select backfill is placed to a height of about 0.7 times the pipe diameter to provide side support. Above that, compacted backfill and topsoil cover the pipeline to finish grade. Pipeline construction work could occur year round.

Pipe Hydraulics

At peak design flow and a minimum Black Rock reservoir water surface elevation of 1500 feet, the hydraulic grade line of the pipeline provides a positive hydraulic head at the highest elevation along the profile and allows water to flow downhill to a Sunnyside powerplant. Excess hydraulic head generates electricity at the powerplant, which has turbines designed for an average 900-cfs flow. Excess flow at the powerplant passes through a bypass structure, pressure reducing valves, and discharges into Sunnyside Canal.

The following Hazen-Williams Formula calculates friction loss for pipeline flow:

$$h_f = \frac{4.72Q^{1.852}L}{C^{1.852}D^{4.87}}$$

where; h_f = head loss (feet)

Q = discharge (cfs)

L = length of pipe (feet)

C = Hazen-Williams roughness coefficient

D = diameter (feet)

Table B-1 in Appendix B shows the pipeline's hydraulic design calculations. A 12-foot-inside-diameter steel pipe keeps velocities under 12 feet per second. A 210-foot static hydraulic head at the start of the pipeline is required to deliver water to Sunnyside Canal. This results in a minimum 438-foot hydraulic head delivered at the new Sunnyside powerplant. The maximum hydraulic head delivered to the powerplant occurs when Black Rock reservoir is at maximum water surface elevation 1778 feet. This results in a maximum 743-foot hydraulic head at Sunnyside powerplant (see table B-2).

Pipe Design

The maximum internal pressure on the pipe controls the required pipe wall thickness. Two conditions are analyzed to determine the maximum pressure: maximum static hydraulic head and maximum transient hydraulic head. The maximum static hydraulic head occurs when Black Rock reservoir is at maximum water surface elevation 1778 feet and there is no flow in the pipe. This condition pressurizes the pipe to the full reservoir water surface elevation. The maximum transient hydraulic head condition is the result of closure of the powerplant valves. The maximum transient elevations used in the design are: elevation 1947 feet at the start of the pipe, elevation 2038 feet at the high point along the pipe, and elevation 2143 feet at Sunnyside Canal powerplant. The *Appraisal Assessment of the Black Rock Alternative Facilities and Field Cost Estimates, Technical Series No. TS-YSS-2* report identifies the hydraulic transient calculations. For these two conditions, transient elevations control the design.

The steel pipe design is based on guidelines from the American Water Works Association (AWWA) Manual M11. The following formula calculates the wall thickness:

$$t = \frac{p d}{2 s}$$

where; t = wall thickness (in.)

p = pressure (psi)

d = outside diameter of pipe (in.)

s = allowable stress (psi)

The allowable stress is 50 percent of yield stress. ASTM (American Society for Testing and Materials) A572, Grade 60 steel pipe is used.

In addition to the above wall thickness calculation, AWWA M11 specifies a minimum wall thickness for handling based on the following formula:

$$t = \frac{D + 20}{400}$$

where; t = wall thickness (in.)

D = diameter of pipe (in.)

Table B-3 (Appendix B) shows pipe wall thickness calculations.

PLAN 2 – MODIFIED ROZA CANAL AND NEW PIPELINE

Plan 2 includes a modified Roza Canal, wasteway, and a new pipeline to convey water to the Sunnyside Canal and involves the following actions:

- Constructing a new siphon on Roza Canal from Station 1349+00 to Station 1351+95.
- Enlarging the existing Roza Canal from Station 1351+95 to Station 1594+72.
- Constructing a new tunnel from Station 1594+72 to Station 1634+60.

- Enlarging the existing Roza Canal from Station 1634+60 to Station 1689+89.60.
- Enlarging the existing Roza wasteway No. 3 from Station 2+17.72 to Station 95+00.
- Constructing a new pipeline from wasteway No. 3 Station 95+00 to a new Sunnyside Canal powerplant.

Roza Irrigation District has indicated the maximum flow downstream from Roza Canal MP 22.6 is currently about 885 cfs. However, the original design flows of the siphon, Roza Canal, and Wasteway No. 3 will be retained in the modifications and additional capacity of 1,262 cfs will be added to these facilities to convey the Sunnyside Division's Columbia River exchange water.

Construction work for the Roza system modifications likely will occur over two or three nonirrigation seasons, being coordinated so the system can continue to operate during irrigation season. Drawing No. 33-100T-3292 (Appendix A) shows the plan view of the alignment. Modifying Roza Canal and wasteway No. 3 requires acquisition of about 40 acres for additional right-of-way that is equal to the increased canal and wasteway widths and a 120-foot-wide right-of-way for the new pipeline.

New Siphon, Station 1349+00 to Station 1351+95

Black Rock reservoir water releases flow through a new Black Rock powerplant (described in the Black Rock Alternative facilities report) and then discharges into Roza Canal just upstream from a new concrete siphon beginning at Station 1349+00. The new siphon is designed for a flow of 1,300 cfs (Roza) plus 1,262 cfs (Sunnyside), for a total flow of 2,562 cfs. The siphon is similar to an existing concrete siphon at Station 1349+30 as shown on Drawing No. 33-D-1146 (Appendix A), except for a new 24-foot barrel diameter.

Enlarged Canal, Station 1351+95 to Station 1594+72

Enlarging the concrete-lined section of Roza Canal from the new siphon to the inlet of tunnel No. 5 will convey the additional Sunnyside flow (see Drawings Nos. 33-100T-3293 and 33-100T-3294 in Appendix A). Enlargement is possible by excavating the left side of the canal with the exception of the existing pumping plants P4 and P5. Near these two plants, the excavation transitions to the right side of the canal upstream from each plant and then transitions back to the left side downstream from each plant. This maintains the existing 0.00039-foot-per-foot canal slope, but widens the canal bottom width from 12 feet to 35 feet. Canal modifications meet current Reclamation standards that include 20-foot-wide operation and maintenance roads on both sides of the canal, gravel surface

roads, and 1½:1 canal side slopes. Drawing No. 33-100T-3297 (Appendix A) shows a typical modified Roza Canal section.

A new 4-inch-thick reinforced concrete lining and new longitudinal and lateral drains replace the entire existing concrete lining and drains. The modification also includes new cross drainage inlet structures and bridges over the canal. Existing turnout structures are not replaced.

Two new check structures (one at Station 1473+00 and one Station 1594+00) constructed in this canal reach each contain two 26-foot-long Langemann Gates. The check structures maintain a canal water surface similar to that of the original canal for continued service to existing pumping plants and farm turnouts. Checks control the flow depth and limit the velocity in the canal. For a typical maximum 2,147-cfs canal flow (1,262 cfs for Sunnyside and 885 cfs for Roza), the maximum canal velocity is approximately 6 feet per second. For a 2,562-cfs design flow (1,262 cfs for Sunnyside and 1,300 cfs for Roza), the velocity is approximately 7 feet per second.

New Tunnel, Station 1594+72 to Station 1634+60

The design capacity of the existing tunnel No. 5 is 1,250 cfs. To accommodate the additional Sunnyside flow, a second tunnel is excavated and constructed on the left side of and parallel to the existing tunnel. The new tunnel is identical to the existing tunnel (Drawing No. 33-D-1171, Appendix A). Both tunnels would deliver water to users.

Enlarged Canal, Station 1634+60 to Station 1689+89.60

The existing canal from the downstream end of tunnel No. 5 to the wasteway No. 3 check and turnout (see) contains two sections of concrete-lined canal at a 0.00039-feet-per-foot slope and two sections of unlined canal at a 0.00011-feet-per-foot slope. A new reinforced concrete-lined canal with drains stretches throughout this entire reach with a 0.0003-feet-per-foot slope. The bottom width of the existing lined sections increases from 12 feet to 35 feet. The existing unlined canal section maintains its 36-foot bottom width, but has a small change to the canal invert. Modifications to these sections of the canal increases the design flow capacity of 1,262 cfs for delivery to Sunnyside, plus 1,250 cfs which is the original design capacity of this reach of the Roza Canal, for a total design flow capacity of 2,512 cfs.

Enlarged Wasteway No 3, Station 2+17.72 to Station 95+00

Modifying the Roza Canal check and turnout structure and this section of wasteway No. 3 increases the design flow capacity of 1,252 cfs to 2,514 cfs to accommodate the additional Sunnyside delivery flow (see Drawing No. 33-100T-3295, Appendix A). The existing check and turnout structure is shown on Drawing No. 33-D-1717 (Appendix A). The structure is modified by constructing a new turnout parallel to the existing wasteway turnout that contains three 6-foot by 6-foot slide gates as shown on Drawing No. 33-100T-3298 (Appendix A).

The existing 0.004-foot-per-foot wasteway channel slope is maintained, but the bottom width increases from 6 feet to 35 feet. Drawing No. 33-100T-3297 (Appendix A) shows a typical modified wasteway section. A new 4-inch-thick reinforced concrete lining replaces the entire existing concrete lining. New longitudinal and lateral drains beneath the lining replace the old drains.

Five new check/drop structures, constructed at 2,000-foot intervals, are located as shown on Drawing No. 33-100T-3295 (Appendix A). Each structure contains two 26-foot-long Langemann Gates to increase the flow depth and reduce the wasteway velocity. A typical maximum 1,262-cfs Sunnyside delivery wasteway flow has a maximum velocity of approximately 6 feet per second. A maximum 2,514-cfs design flow has a maximum velocity of approximately 9.5 feet per second. Drawing No. 33-100T-3300 (Appendix A) shows a typical check/drop structure.

New Pipeline, Wasteway, Station 95+00 to Sunnyside Canal Powerplant

A turnout structure (Drawing No. 33-100T-3301, Appendix A) constructed on wasteway No. 3 at Station 95+00 diverts Sunnyside flow to a 12-foot-diameter pipeline that extends for about 4,380 feet to Sunnyside Canal powerplant as shown on Drawing No. 33-100T-3296. A Langemann Gate structure constructed in the wasteway at Station 96+50 downstream from the pipeline turnout diverts flow into the pipeline. The pipe details are the same as for Plan 1 - delivery pipeline. Wasteway flows in excess of the 1,262-cfs Sunnyside delivery continue down wasteway No. 3 and into the Yakima River. Waste flows due to powerplant shutdown automatically bypass the powerplant and flow through pressure reducing valves into Sunnyside Canal.

Pipe hydraulic calculations are similar to Plan 1, except that this pipe is unaffected by the Black Rock reservoir water surface elevation. Table C-1 in Appendix C shows the pipe hydraulic calculations for this option. Approximately 222 feet of hydraulic head is delivered to the powerplant. Steel pipe wall thickness calculations for this option (table C-2, Appendix C) are similar to Plan 1. ASTM A36 steel pipe is used.

SUNNYSIDE CANAL MP 3.83 – BOTH PLANS

Both Sunnyside delivery plans include constructing a powerplant, check structure, and a pipeline at Sunnyside Canal MP 3.83. Drawings Nos. 33-100T-3287, 33-100T-3290, 33-100T-3292, 33-100T-3295, and 33-100T-3296 (Appendix A) contain plan views showing the location of these facilities.

Powerplant and Bypass

A powerplant at the delivery point at Sunnyside Canal MP 3.83 recaptures a portion of the energy created from releasing water from Black Rock reservoir and a powerplant bypass provides continued flow to Sunnyside Canal when the powerplant is offline. The potential powerplant would have a turbine design discharge of 900 cfs and output of 29.5 MW for Plan 1 and 15 MW for Plan 2. The *Appraisal Assessment of the Black Rock Alternative Facilities and Field Cost Estimates, Technical Series No. TS-YSS-2* report addresses the powerplant and bypass structure.

Delivery to Sunnyside Division Lands Upstream from Sunnyside Powerplant

The delivery to Sunnyside Division is at Sunnyside Canal MP 3.83. The majority of the powerplant discharge flows into Sunnyside Canal for delivery to downstream water users. However, a small number of Sunnyside water users are upstream from the powerplant. A check structure in Sunnyside Canal adjacent to the powerplant prevents water from “backing up” the canal. The check structure is similar to the existing Langemann Gate structures on Sunnyside Canal. A small pumping plant at Sunnyside Canal MP 3.83 pumps 17 cfs through a 3.2-mile-long PVC pipe that is buried in the embankment on the right side of Sunnyside Canal. The pump and pipe provide pressure delivery to water users upstream from the check structure. The pipe varies in diameter from 18 inches at MP 3.83 to 6 inches at the upstream end at MP 0.61. Table D-1 in Appendix D shows the pipe hydraulic calculations.

FIELD CONSTRUCTION COST ESTIMATES

Calculating material quantities of each item (based on available data and professional judgment) and applying June 2004 unit prices provides preliminary appraisal-level cost estimates the two downstream plans. Reclamation's field construction costs are the estimated actual in-field contract cost of project construction pay items plus the following:

- Costs for mobilizing contractor personnel and equipment to the project site during initial project startup. *Mobilization* and preparation work is estimated at 5 percent of the total pay-item cost estimate.
- A contingency for *unlisted items* such as those which could be incurred with design changes and "pay items" that have not been itemized. Unlisted items are estimated as 15 percent of the total pay item and mobilization cost. The sum of the pay items, mobilization, and unlisted items is collectively referred to as the construction contract cost.
- *Contingencies* reflect funds to be used after construction starts resulting from overruns on quantities, changed site conditions, changed work orders, and other unforeseen items. Contingencies are estimated as 25 percent of the construction contract cost.

Further, additional noncontract cost will need to be incurred once a proposed Federal water resource project is authorized and Congress provides construction appropriations. These additional costs include such items as preparation of final engineering designs and specifications, regulatory compliance and permitting activities, environmental mitigation and monitoring, and construction contract administration and management. Right-of-way acquisition costs for project construction and subsequent project operation must also be included.

Plan 1 – Delivery Pipeline

The excavation quantity for pipeline construction is based on 10-foot-contour-interval topography. Land Development Desktop software calculates the total excavation quantity. Based on geologist's visual observations, rock excavation is estimated to occur between approximately pipeline Station 205+00 and Station 255+00, or about 15 percent of the length of the pipeline. Therefore, 85 percent of the excavation is estimated as common excavation. The cost estimate worksheet on table E-1 (in Appendix E) shows all the individual project items and costs for this option. The total field construction cost is \$210 million. These costs do not include a new Sunnyside powerplant and bypass structure.

Plan 2 – Modified Roza Canal and New Pipeline

Quantity estimates for Roza Canal, wasteway, and new pipeline modifications are based on the original construction drawings in Reclamation Specifications (33-D-1042, 33-D-1134, 33-D-1135, and 33-D-1136) for building those facilities. Typical cross sections, ground slopes for the topography, and the original ground surface provide information for calculating excavation and embankment quantities. Figure C-3 and tables C-4 through C-6 in Appendix C show the excavation and embankment quantity calculations for Roza Canal modifications. Figures C-7 and C-9 and tables C-8 and C-10 show the excavation and embankment quantity calculations for wasteway No. 3 modifications. Quantities for estimating the new tunnel came from the original construction drawing for the existing tunnel. The cost estimate worksheet on table E-2 (in Appendix E) shows all the individual project items and costs. The total field construction cost is \$68 million. These costs do not include a new Sunnyside powerplant and bypass structure.

Table 2. Cost Summary of Black Rock Delivery Systems for Sunnyside Division

Item	Plan 1 – Delivery Pipeline	Plan 2 – Modified Roza Canal and New Pipeline
Subtotal of Pay Items	\$138,200,000	\$44,800,000
Mobilization (5%)	\$6,900,000	\$2,200,000
Unlisted items (15%)	\$19,900,000	\$7,000,000
Construction Contract Cost	\$165,000,000	\$54,000,000
Contingencies (25%)	\$45,000,000	\$14,000,000
Total Field Construction Cost	\$210,000,000	\$68,000,000